

GOVERNMENT OF INDIA
MINISTRY OF FOOD AND AGRICULTURE

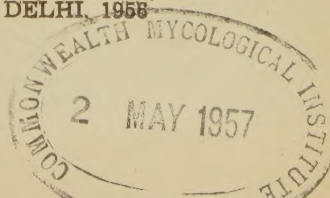


समर्थ चक्र

Annual Report
OF THE
CENTRAL RICE RESEARCH
INSTITUTE, CUTTACK

FOR THE YEAR 1954-55

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ANNUAL REPORT OF THE CENTRAL RICE RESEARCH INSTITUTE, CUTTACK FOR THE YEAR 1954-55

SEASON AND CROP CONDITIONS

The monsoon set in by the 1st of June, but there was a prolonged break in the rains during the month of July which caused delay in transplanting of crop. The total precipitation during the year was 57.76" as against the normal annual rainfall of 56.80", but the distribution was rather erratic. The distribution of rainfall as compared to the mean of the decade 1940—1949 is given in Table I.

TABLE I—Rainfall in inches

	1954-55	Average of 10 years 1940-49
S.W. Monsoon :		
June, 1954	9.22	6.88
July, 1954	7.18	15.41
August, 1954	12.35	12.49
September, 1954	14.62	7.77
	<u>43.37</u>	<u>42.55</u>
Post Monsoon :		
October, 1954	9.49	7.10
November, 1954	0.00	1.65
	<u>9.49</u>	<u>8.75</u>
Winter rain :		
December, 1954	0.26	0.51
January, 1955	0.00	0.48
February, 1955	0.00	1.00
	<u>0.26</u>	<u>1.99</u>
Summer or Pre-monsoon :		
March, 1955	0.55	0.79
April, 1955	0.37	1.29
May, 1955	3.72	1.43
Total	<u>56.76</u>	<u>56.80</u>

The crop condition was fair. The medium duration varieties, which were in full flowering during the month of September, suffered due to excessive rain during this month. There was no serious attack of any disease or insect pests and periodic spraying was given as a prophylactic measure.

AGRONOMY

I. Varietal Trials

Yield performance of 121 varieties, grouped according to duration, was tested in five varietal trials during the main crop season and that of 36 varieties during the second crop season. Besides this, 116 types were grown in observation plots to determine their suitability for the second crop season.

In 85—110 days' duration trial, which was conducted this year under only transplanted conditions, 8 out of 20 varieties tried, yielded better than the control, *Benibhog*, which gave 1964 lb. per acre. Variety Ch. 62, which gave 2328 lb. per acre, was significantly superior to the control.

In 110—125 days' duration trial, repeated this year with the same 28 varieties as tried last year, five varieties yielded better than the control, T. 635, which gave 2,200 lb. Three of these varieties, PTB. 13, Cross-116, and MGL.2, which gave 2899 lb., 2764 lb. and 2579 lb. per acre respectively, were significantly superior to the control.

In 125—140 days' duration trial, 32 varieties were tested with SLO. 6 as the control. Varieties T. 1879, T. 141-89, SL. 202 Kalamdani, T. 837 and BK. 6 yielded 10.6 to 19.9 per cent better than the control which yielded 3250 lb. per acre. T. 1879 which yielded 3898 lb. was significantly superior to the control. Variety T. 141-89, which is a selection from the popular improved variety, T. 141, yielded 16.4 per cent better than the original T. 141, thus confirming the previous results.

In 150—160 days' duration trial, 27 varieties were tested with T. 1242 as the standard which yielded 3247 lb. per acre. Variety BAM. 9, which has given the highest yield in the trial during the past two years, again yielded the best, giving 3634 lb. per acre which was 11.9 per cent significantly more than the control.

In the trial of varieties of over 170 days in duration none of the 14 varieties tested did better than the control, T. 1242, which gave 3021 lb. per acre.

Among the 36 varieties tested for their suitability for cultivation in the second crop season, the performance of eight was found promising. Variety, Mtu. 15, which gave the highest yield of 1744 lb. per

acre, was found to be about 2-3 weeks later in maturity than the control, PTB. 10 which yielded 1092 lb. per acre.

II. Manurial Trials

Efficiency of nitrogenous fertilizers for rice

The experiment was conducted as in last year, to test the relative efficiency of 8 different forms of nitrogenous fertilizers, viz., ammonium chloride, ammonium sulphate, ammonium phosphate, ammonium sulphate-nitrate, urea, ammonium nitrate, calcium cyanamide, and sodium nitrate. The fertilizers were applied at two levels of 20 and 40 lb. N per acre at the time of planting. The yield responses obtained with various fertilizers are given in Table II below:

TABLE II.—*Response of rice in lb. per acre*

	Nitrogen 20 lb.	Levels. 40 lb.	Mean	C.D.(.05) (forms)
Ammonium chloride	869	1338	1103	204
Ammonium sulphate	708	1257	983	
Ammonium phosphate	659	1281	970	
Ammonium sulphate-nitrate	562	768	665	
Urea	436	804	620	
Ammonium nitrate	462	479	470	
Calcium cyanamide	74	380	227	
Sodium nitrate	93	41	67	
No manure (Control)	1699 lb. per acre.			

As already reported, during the previous year the response to various fertilizers was low, due to the control yield itself being high, viz., 2799 lb. per acre. This year, however, the yield response to the various fertilizers is high and increasing yields have been obtained with increasing levels of nitrogen application.

It will be seen that all the fertilizers except calcium cyanamide and sodium nitrate have given significantly high yield responses. The response with ammonium chloride was the highest viz., 869 and 1338 lb. per acre with 20 and 40 lb. N per acre, respectively. However, there were no significant differences between response obtained with ammonium chloride, ammonium sulphate and ammonium phosphate.

Experiments are being conducted to investigate differential response of N. fertilizers in different seasons and also to investigate whether fertilizers act differently when applied at different stages of plant growth.

Placement and split application of ammonium sulphate for rice

This experiment has been in progress since 1952-53 with a view to study the effect of placement of fertilizers in split doses at different stages of plant growth on crop yield, and was repeated this season for the third year in succession, with the long duration variety T. 1242 (160 days) under low lying conditions. The results are presented in Table III below:

TABLE III.—Yield of grain in lb. per acre
(Variety T. 1242.)

Treatment	Nitrogen level lb. per acre		Mean
	20 lb.	40 lb.	
1. No manure (Control)	..	2243	2243
2. Surface application at planting	2611	2842	2726.5
3. Surface application one month after planting	2581	2968	2774.5
4. Sub-surface 'dry' application before planting	2445	2874	2659.5
5. Sub-surface 'pellet' application at planting	2681	3308	2994.5
6. Sub-surface 'pellet' application one month after planting	2762	3168	2965.0
7. $\frac{1}{2}$ Sub-surface 'dry' + $\frac{1}{2}$ surface one month after	2693	2965	2829.0
8. $\frac{1}{2}$ Sub-surface 'dry' + $\frac{1}{2}$ pellet one month after	2695	3140	2917.5
9. $\frac{1}{2}$ Surface at planting + $\frac{1}{2}$ surface one month after	2597	2779	2688.0
10. $\frac{1}{2}$ Surface at planting + $\frac{1}{2}$ 'pellet' one month after	2700	2811	2755.5
11. $\frac{1}{2}$ Surface at planting + $\frac{1}{4}$ one month after + $\frac{1}{4}$ before flowering	..	3166	3166.0
12. $\frac{1}{2}$ Sub-surface dry + $\frac{1}{4}$ surface one month after + $\frac{1}{4}$ surface before flowering	..	2714	2714.0
13. $\frac{1}{2}$ Sub-surface 'pellet' + $\frac{1}{4}$ 'pellet' one month after + $\frac{1}{4}$ 'pellet' before flowering	..	3369	3369.0
Mean	2640.5	3008.7	
C.D.(.05) to compare level means	126.7		
C.D.(.05) to compare individual treatments	380.0		

The results obtained are in conformity with those of last year. Fractional application of the fertilizer has again given better yields than entire quantity applied in one dose and the highest response was obtained as previously, with sub-surface application of the fertilizer in three doses, viz., $\frac{1}{2}$ at planting, $\frac{1}{4}$ one month after planting and $\frac{1}{4}$ just before flowering to supply in all 40 lb. N per acre. The yield response obtained with different methods of applications and the fractional doses of the fertilizer at 20 and 40 lb. N. per acre averaged over other factors are given in Table IV below:

TABLE IV.—Average response of paddy in lb. per acre

Treatments	Nitrogen in lb. per acre	
	20 lb. N/A	40 lb. N/A
<i>I. Method of application</i>		
(a) Surface application	353	695
(b) Sub-surface application	386	939
<i>II. Fractional application</i>		
(1) Single application	373	789
(2) Fractional application in two doses	428	681
(3) Fractional application in three doses		840

Long range manurial experiments

These experiments, as previously reported, are designed to investigate the cumulative effect of continuous application of various fertilizers and manures on the condition and productivity of rice soil.

(i) *Ammonium sulphate, with and without lime and compost.*—This experiment was continued on the same site for the seventh year in succession to see whether any deleterious effect would result from continuous application of inorganic fertilizers to rice soils and whether such an effect, if any, could be counteracted by application of lime and compost. The results are presented in Table V below:

TABLE V.—Grain yield in lb. per acre
(Variety T. 1145.)

Basal dressing of Lime in cwt. per acre	Top dressing of ammonium sulphate-nitrogen lb./A.								
	No compost.				Compost at 100 md./Acre				Mean
	No	N 20	N 40	Mean	No	N 20	N 40	Mean	
Lo.	1928	2649	2810	2462	2538	2908	3131	2859	2660
L4.	2019	2777	2615	2470	2641	2864	3233	2912	2691
L8.	2023	2492	2930	2482	2677	3130	3164	2990	2736
Mean	1990	2639	2785	2471	2618	2967	3176	2920	2696

So far no deleterious effect has been found in the plots to which ammonium sulphate alone has been applied continuously. Lime application, either alone or in conjunction with N, had no effect on yield of rice. Basal dressing of compost and top dressing with ammonium sulphate, as in previous years, have given increased yields.

(ii) *Ammonium sulphate with and without compost.*—This experiment was conducted for the 6th year in succession on the same site. The results are given in Table VI below:

TABLE VI.—Grain yield in lb. per acre
(Variety T. 1145)

Top dressing of ammonium sulphate-nitrogen lb/A.	Basal dressing of compost in maunds per acre.		
	C ₀	C ₁₀₀	Mean.
No	1982	2519	2250
N 20	2261	2792	2527
N 40	2718	3110	2914
N 60	3020	3193	3107
N 80	2961	2997	2979
Mean	2589	2922	

C.D.(.05) for comparing compost means 199.8

C.D.(.05) for comparing nitrogen means 139.1

C.D.(.05) for comparing nitrogen levels at the same level of compost . . . 196.6

C.D.(.05) for comparing two compost levels at the same level of nitrogen . 260.1

As in previous years the effect of ammonium sulphate was significant as also its interaction with basal dressing of compost. This year compost application gave a high response (537 lb. per acre). In case of ammonium sulphate applied alone there was significant yield increase upto 60 lb. N/A; but when applied over a basal dressing of compost the yield increased significantly only upto 40 lb. N/A; with 80 lb. N/A yield was depressed in both cases.

The yield-N relationship can be represented by the quadratic curve as given by the equation:

$$\text{No compost—} Y = 1926.44 + 509.66 X - 59.44 X^2$$

$$\text{Compost—} Y = 2483.85 + 470.19 X - 83.68 X^2$$

Where Y is the expected yield in lb. per acre and X is the N level, per acre, each unit of N. being 20 lb. N. per acre. From the yield—nitrogen quadratic function, the estimated maximum yields of 3144 and 3019 lb. per acre were obtained with 56 and 86 lb. N/A with compost and no compost respectively, applied with ammonium sulphate.

(iii) *N. P. K. Experiment.*—The experiment, now in the 6th year is designed to investigate the suitable combination of the major plant nutrients, N, P and K and to estimate their comparative performance with the basal dressings of organic manures. Previously the fertilizers were applied at three levels to supply 0, 20 and 40 lb. of N, P₂O₅ and K₂O. During the current season, the fertilizer doses were modified. Ammonium sulphate was applied at 0, 40 and 80 lb. nitrogen per acre, super phosphate was 0, 50 and 100 lb. P₂O₅ per acre and potassium sulphate at 0, 30 and 60 lb. of K₂O per acre. The basal dressings of organic manures were applied as in previous years to supply 20 lb. N per acre.

The yield data are presented in Table VII below:

TABLE VII—Yield of grain in lb. per acre
(Variety T.1145)

Top dressing of ammonium sulphate at N lb/A.	Basal dressings of organics at 20 lb. N/A				Mean.	C.D. (.05)
	No manure	Compost	Groundnut cake	Dhaincha		
No . . .	1631	1845	1605	1777	1715	107
N 40 . . .	1863	2070	1609	1919	1865	
N 80 . . .	1748	1940	1363	1725	1694	
Mean . . .	1747	1952	1520	1807		

It was found, as in previous years, that neither phosphate nor potash had any effect on rice yield, whether applied alone or in combination with inorganic or organic. Similarly, the differences due to organic manures were not significant and nitrogen application gave significant increase in yield upto 40 lb. N. level.

III. Cultural Trials

Crop sequence experiment

This experiment, which was begun last year to determine the possibility of growing different legume and cash crops in sequence with main season rice crop, was repeated with twelve rotational treatments in three replications. Eight different crops, besides *dalua* or *boro* crop of rice were grown during the preceding winter season to determine their suitability for inclusion in the sequence of cropping with rice and to study their economics and effect on the succeeding rice crops. The yield data are presented in Table VIII below:

TABLE—VIII

Rotational treatment ₁	Yield in lb. per acre	
	Preceding subsidiary crop	Succeeding rice crop (Variety PTB. 10)
1. Fallow/Rice	..	3414
2. Rice/Rice	1823	3116
3. Rice following green manuring with <i>dhaincha</i> /Rice	2193	2814
4. Rice following green manuring with <i>mung</i> /Rice	2548	3570
5. Mung for seed/Rice	476	3332
6. Mung for seed Pillipesara/Rice	551	3654
7. Gram/Rice	1217	3296
8. Groundnut/Rice	1172	3604
9. Wheat/Rice	444	3301
10. Cotton/Rice	896	3032
11. Linseed /Rice	274	3170
12. Mustard/Rice	205	3352
C.D. (.05)		203.4

Among the crops tested, groundnut, cotton and gram appear to be suitable for inclusion in the sequence of cropping with rice and would give a good economic return to the grower. Groundnut crop, besides giving good yield, has also a beneficial effect on the yield of the succeeding rice crop.

For double cropping of rice, the growing of *mung* crop for green manuring of *dalua* rice crop gave the highest yield.

Three crops of rice per year

The possibility of growing three crops of rice in a year on the same land was explored. Periodical plantings of different varieties were carried out under irrigated conditions. Results obtained show that with an assured irrigation supply, the total yield of as much as 9298 lb. of paddy per acre can be obtained by adopting the following sequence of cropping and judicious manuring:

- (1) First crop of a short duration variety (Ch. 45) planted by middle of April and harvested by last week of June.
- (2) Second crop of medium duration variety (T. 141) planted in main season from July—December.
- (3) Third crop of short duration rice planted by middle of January and harvested by early April.

The data are presented in Table IX below:

TABLE IX

	1st crop	2nd crop	3rd crop	Total yield
Variety	Ch.45	T.141	Ptb.10	
Date of planting	15-4-54	31-8-54	17-1-55	
Date of harvesting	24-6-54	9-12-54	9-4-55	
Yield of grain in lb. per acre	2866	3348	3084	9298
Yield of straw in lb. per acre	6290	4058	3229	13577

Herbicides for weed control in rice fields

The experiment was repeated to evaluate the comparative efficiency of various formulations of selective herbicides for control of weeds in rice fields. The treatments included four different herbicides at 2 lb. acid equivalent in 100 gallons of water, customary hand weeding, and inter-culturing with Japanese rotary weeder.

The herbicides were sprayed at six and nine weeks after transplanting of crop. In the later case one weeding was given six weeks

after transplanting. The results obtained are given in Table X below:

TABLE—X
(Variety T. 141)

Treatment	Yield of Paddy in lb. per acre.	Percentage on control.
No weeding (Control)	3830	100.0
Hand weeding—Twice	4288	111.9
Japanese rotary weeder—Twice.	4162	108.7
Phenoxylene 30.	4586	119.7
Chloroxone (2,4-D).	4249	110.9
K.M.7	4273	111.7
2,4,5-T.	4099	107.0
Hand weeding+Phenoxylene	3438	89.8
Hand weeding+Chloroxone	3315	86.8
Hand weeding+K.M.7	3187	83.2
Hand weeding + 2, 4, 5-T	2545	66.4
S.E. for the mean.	69.4	
C.D.(.05)	200.0	

Phenoxylene 30 (M.C.P.A.) applied six weeks after planting gave significant increase in yield over all the treatments. Other formulations though significantly superior to no weeding (control), were not found to be superior to customary hand weeding.

Application of herbicides at later stages of crop growth following customary hand weeding was found to cause injury to the rice plant resulting in low yield.

IV. Cultural-cum-Manurial Trials

The merits of various operations recommended under the Japanese method of rice cultivation were tested in a 2⁶ confounded experiment as in last year as per coordinated plan drawn by the Indian Council of Agricultural Research. The following six treatment combinations were included in the trial:

Treatment	Japanese method	Local method
(i) Seed rate	15 lb. per acre	32 lb. per acre.
(ii) Seed bed preparation	(a) Raised seed bed (b) Sifting of seed and dipping in brine solution	Flat seed bed.
(iii) Nursery manuring	Application of manure and fertilizer to nursery for planting an acre— Compost —1600 lb. ammonium sulphate—20 lb. $\frac{1}{2}$ " layer of ash.	Only compost at 1000 lb.
(iv) Method of planting	Transplanting in straight lines at 10"×10" with 4 seedlings per hole.	Bulk transplanting 6"×8" apart 3-4 seedlings per hole.

1	2	3
(v) Field manuring	(a) Basal dressing at the rate of 5 tons compost and 6000 lb. of green leaf. (b) Sub-surface application at the rate, 100 lb. Ammonium sulphate and 100 lb. Super phosphate per acre at planting.	Basal dressing of compost at $2\frac{1}{2}$ tons per acre. No top dressing.
(vi) Interculturing & weeding.	Interculturing with Japanese weeder thrice.	Hand weeding twice.

A medium duration variety, T. 141, was used and the crop condition was satisfactory.

Out of the six factors tested, only one factor, i.e., field manuring, was found to be statistically significant. Field manuring according to Japanese method depressed the yield of the grain to the extent of 591 lb. per acre.

V. Coordinated trials

As a measure of coordination between the various Central Institutes, it has been decided to conduct trials simultaneously at different Institutes to test the results under different climatic and soil conditions. During the year, trials with N. P. Wheat and linseed varieties were conducted at this Institute in cooperation with the Indian Agricultural Research Institute, New Delhi. A trial with *durum* wheat varieties from Indore was also conducted, but most of the varieties were affected by leaf blight caused by *Alternaria* sp.

(i) *Wheat varietal trial*.—Ten improved N. P. Wheats were tested in a replicated trial. The results of the experiments are given in Table XI below:

TABLE XI

Variety	Yield in lb. per acre
1. N. P. 718	1257
2. N. P. 755	1223
3. N. P. 710	1168
4. N. P. 761	1162
5. N. P. 799	1158
6. N. P. 737	1152
7. N. P. 798	1133
8. N. P. 797	970
9. N. P. 721	948
10. N. P. 792	938
Mean.	1112
S.E.	117.1
C.D.(.05)	339.7

Variety N. P. 718, which gave the highest yield last season, again gave the best performance during this season.

(ii) *Linseed varietal trial*.—Seven improved varieties from the Indian Agricultural Research Institute were tested in a replicated yield trial. The results obtained are presented in Table XII below:

TABLE XII

Variety		Yield in lb. per acre
1. R. R. 9.		626
2. R. R. 45		589
3. R. R. 439		552
4. R. R. 5		529
5. R. R. 431		471
6. R. R. 40.		466
7. R. R. 440.		431
Mean.		533
S.E.		40.3
C.D.(.05)		120.0

As in last year, variety R. R. 9 gave the best yield this year.

STATISTICS

Besides helping the various research divisions in the design and interpretation of experiments, the following investigations were undertaken.

I. Standard Errors in field experiments

A study of the distribution of standard errors of plot yields of the various experiments in randomised block layouts with plot sizes ranging from 1/50 to 1/1000 acre, from 1949-50 to 1954-55, showed that C. V. ranged from 1.2 to 27 per cent. depending upon the size of the plots and number of plots per block. The mean and modal values worked out to be 10.51 and 7.22 per cent, respectively. In 75 per cent. of the experiments C. V. ranged between five to thirteen per cent.

II. Intra-Varietal Correlation studies

Multiple correlation co-efficients were calculated in seven short duration varieties between yield and number of earheads, length of earhead, and height of plant at harvest. It was observed that the joint contribution of all the three characters towards yield ranged

from 23 to 66 per cent. whereas that of ear-length and earhead number, earhead number and height, and ear-length and height ranged from 18 to 66, 11 to 25, and 8 to 40 per cent. respectively. The individual contribution of number of earheads, length of earhead and height of plant towards yield ranged from 10 to 44, 5 to 57 and 0 to 6 per cent, respectively. Contributions of height towards yield was found to be negligible in almost all the varieties. The magnitude of contribution by the other two factors varied from variety to variety. The results are presented in Table XIII below:

TABLE XIII—Percentage contribution of individual as well as various combinations of characters towards yield

Percentage contribution due to	Varieties.						
	ADT.3	ADT.4	PLR.2	B. 76.	N.136	DCA.14	PLR. 7
(i) No. of ear heads .	10.88	37.36	15.24	16.71	18.08	10.39	43.69
(ii) Length of ear head.	22.90	37.49	23.67	8.55	27.82	5.19	57.43
(iii) Height of plant	1.44	4.29	0.93	0.0005	0.12	6.05	0.94
(iv) Earhead number, ear length and height of plant.	26.26	51.54	36.06	23.17	38.12	22.97	66.34
(v) Earhead number and earhead length. .	30.24	49.41	36.37	23.69	33.58	17.99	66.02
(vi) Earhead number and height of plant. . .	11.37	24.77	16.20	16.59	14.30	18.75	20.95
(vii) Earhead length and height of plant. . .	22.29	22.19	24.52	8.34	24.49	14.02	40.25

III. Serial correlation in field experiments

Uniformity trial data collected in the year 1949-50, were utilised in working out the serial correlation coefficient and also to obtain information regarding the fertility gradient of the field. Co-efficients of different orders in respect of both horizontal and vertical components were calculated with varying plot sizes. Higher values were observed in case of vertical sequence, irrespective of plot sizes available, indicating thereby that fertility gradient was more in vertical (W-E) direction. It may, however, be mentioned that differences in the values of the two components were of a very small order.

IV. Border Effect

An investigation was undertaken to study the border effect on the plot yield from two experiments with transplanted paddy, comprising of one short-duration varietal trial and the other a manurial

experiment. The former was planted with 6"×6" spacing and the latter with 10"×10" spacing. Harvesting of each plot was done ring by ring upto the fifth ring.

It was observed that the outermost ring yielded 42 to 90 per cent more per unit area than the central portion in case of manurial trial and 54 to 174 per cent more in case of varietal trial. The second inner ring did not give any appreciable increase over the remaining central area in the manurial trial, whereas in the varietal trial it yielded significantly higher per unit area than the remaining central portion. In subsequent rings there was no significant difference in both the trials. Studies are in progress to investigate the reasons for the different results obtained with the manurial and varietal trials.

The yields in lb. per acre with different plot sizes obtained with successive elimination of rings, are given in Table XIV below:

TABLE XIV—Average yield in lb. per acre for different plot sizes averaged over the treatments and varieties

Experiment	Whole plot	Excluding one row all round	Excluding two rows all round	Excluding three rows all round	Excluding four rows all round	Central area
Varietal . .	2036	1750	1695	1673	1661	1648
Manurial . .	3432	3164	3146	3154	3170	3211

V. Sampling studies

In a preliminary investigation the comparative efficiency of direct sampling and sampling for the ratio of grain to total produce for estimating yield was studied. It was found that the sampling variance for the ratio method is about 25 per cent less than that for the direct estimate, the sampling unit adopted being 2'×2' square.

BOTANY

1. Maintenance and study of genetic stocks.

During the year 224 additions were made to the collection of genetic stocks, which now contains 3150 types. The new additions which included 4 wild species, were received from 12 Foreign countries (Argentina, Burma, French West Africa, Gambia, Japan, Malaya, Nyasaland, Pakistan, Sierra Leone, Thailand, U.S.A. and Vietnam) and some States in India. In response to requests, seed samples of 331 genetic stocks were supplied to 11 countries abroad and to various States in India.

The Director, Central Rice Research Institute continued to be in overall supervision of the Food and Agriculture Organisation Scheme of Maintaining the World Genetic Stock of Rice at 5 centres in the World, including Central Rice Research Institute.

A new type of clustered variety having short compact panicles with 10 to 15 spikelets arranged in whorls in a cluster was received from Travancore-Cochin and the relationship of this new type of cluster habit with the usual cluster habit and the normal habit is being studied.

Observations on the occurrence of anthocyanin pigment in rice varieties in genetic stock, which have been in progress during the last four years, were completed during the year. It was observed that several of the types were pigmented only in one part whereas previously pigmentation has not been reported as occurring in less than two plant parts.

The collection of genetic stocks at the Institute is being continuously sifted to select useful types for introduction from the point of yield and non-lodging habit. During this year 47 promising varieties were selected for yield trials and 11 (9 American and 2 Indonesian varieties) for trial for non-lodging habit.

2. Improving Yield by

A. Introduction

Eighty-seven types were selected from genetic stock during the last season and they were tried in 6 preliminary yield trials with the varieties grouped according to their duration. The results are discussed below.

In the 101—110 days trial none of the types was better than the controls. In 111—120 days trial though none of the types was significantly better than the control, BAM. 12, two types, viz., T.R. 2(AC486) from Travancore-Cochin and U.S.A. 2(AC 566), yielded 13.4 and 11.9 per cent respectively, more than the control yield of 2218 lb. per acre.

In the 121—140 days trial while no type was superior to the control, T. 1145, one type viz., T. 2096 (AC 87) from Assam was significantly superior to the second control, T. 635, yielding 6.5 per cent more.

In 141—150 days trial No. 2 and 151—160 days trial none of the types proved better than the respective controls. In 141—150 days (no. 2) trial, while none of the types was found superior to the control, T. 141, 12 types proved significantly superior to the control T. 1145; these will be further tested.

B. Hybridization

(a) *Between indica and japonica rices*

As previously reported two parallel hybridization projects between the *japonica* and *indica* rices, one sponsored by the F.A.O. and the other by the Indian Council of Agricultural Research are in progress at the Institute. During the year the crossing programme under the F.A.O. project and about half of the programme under the Indian Council of Agricultural Research Scheme were completed. In all, 120 cross combinations were done involving 99,732 cross pollinations and 12,449 cross seeds were obtained.

For growing the F_2 generation, approximately 12.5 lakh seeds and for the BC_1 and BC_2 generations, approximately 99,000 seeds were distributed to the participating Asian countries, viz., Burma, Cambodia, Indonesia, Malaya, Pakistan, New Guinea, Philippines, Thailand and Vietnam and the States in India.

As reported, 1,100 single plant selections were made last year in the F'_3 generation of several cross combinations and the F_4 generation of these selections was studied under normal (40 lb. N plus 17 lb. P_2O_5) and heavily manured (120 lb. N plus 51 lb. P_2O_5) conditions. On the bases of vigour, early maturity, number of ear bearing tillers and panicle character, 3,600 field selections in the cultures were made and out of these 743 single plant selections were retained on the bases of yield, fertility percentage and grain character for further study. The yield of the single plants thus retained ranged between 40 to over 80 gm., while the mean single plant yield of the best *indica* parent was only about 36 gm. The mean single plant yield and sterility percentage of some of the cross combinations are given in Table XV. It will be seen that mean sterility of the F_4 generation ranged between 15.4 to 27.0 per cent, while the sterility percentage in the F_1 generation was between 30 to as high as 86.6 per cent.

The 860 selections made in the F_2 generation last year were studied under both normal and high fertility conditions and 432 were finally retained for further studies.

From 55 other *japonica* $\times$ *indica* cross combinations in the F_2 generation this year 2486 field selections were made of which 681 were finally retained.

TABLE XV.—*Performance of the indica-japonica Selections*

Cross Combinations	F ₁ generation			F ₂ generation			F ₃ generation			F ₄ generation		
	sterility percentage	Indica parent plant yield (gm.)	No. of selections	Mean plant yield (gm.)	No. of selections	Mean plant yield (gm.)	No. of selections	Mean plant yield (gm.)	No. of selections	Mean sterility % (Selections)	Mean plant yield (gm.)	Mean sterility % (Selections)
G.E.B. 24 × Norin 1	63.4	21.2	51	30.1	41	56.0	45	25.5	45	25.5	55.1	25.5
G.E.B. 24 × Norin 6	73.7	21.2	24	31.3	25	56.6	34	24.3	34	24.3	55.6	24.3
G.E.B. 24 × Norin 23	68.3	21.2	5	40.2	17	45.7	10	22.5	10	22.5	40.0	22.5
G.E.B. 24 × Asahi	74.3	21.2	47	44.0	36	45.0	26	23.5	26	23.5	54.8	23.5
G.E.B. 24 × Rikuu 132	68.1	21.2	36	37.0	35	48.0	19	22.7	19	22.7	51.9	22.7
G.E.B. 24 × Taichu 65	67.2	21.2	19	41.1	24	43.0	17	25.5	17	25.5	58.9	25.5
G.E.B. 24 × Taihoku 6	73.0	21.2	22	42.9	21	46.8	23	27.3	23	27.3	50.7	27.3
T. 90 × Aikoku	65.4	20.5	18	38.6	16	41.5	8	17.9	8	17.9	50.4	17.9
T. 90 × Taichu 65	60.2	20.5	2	22.5	11	71.3	5	26.8	5	26.8	63.0	26.8
T. 1145 × Norin 36	76.7	27.4	30	49.2	35	48.8	57	17.7	57	17.7	51.6	17.7
T. 1145 × Asahi	77.6	27.4	23	38.8	37	45.9	23	19.5	23	19.5	53.3	19.5
T. 1145 × Taihoku 6	80.9	27.4	40	34.6	55	48.3	38	18.9	38	18.9	51.4	18.9
T. 1145 × Aikoku	74.9	27.4	15	38.4	22	45.9	16	27.0	16	27.0	54.8	27.0
T. 1242 × Asahi	86.7	36.5	30	37.7	78	48.0	76	24.0	76	24.0	52.9	24.0
T. 812 × Asahi	72.4	22.0	17	45.5	47	47.0	49	20.0	49	20.0	55.5	20.0
B.A.M. 9 × Norin 18	55.2	29.0	43	32.5	54	55.1	23	16.0	23	16.0	56.9	16.0
B.A.M. 9 × Rikuu 132		29.0	30	43.3	54	50.1	62	23.1	62	23.1	56.5	23.1
B.A.M. 6 × Norin 36		34.2	22	43.6	29	48.1	29	25.3	29	25.3	54.6	25.3
B.A.M. 6 × Rikuu 132	87.5	34.2	37	49.4	44	44.1	31	25.1	31	25.1	57.3	25.1
B.A.M. 11 × Taihoku 6	32.0	31.8	20	42.2	39	47.4	18	20.0	18	20.0	57.1	20.0
B.A.M. 11 × Asahi		31.8	19	34.6	21	44.7	14	15.4	14	15.4	57.1	15.4
Patnai × Rikuu 13	69.7	18.3	18	31.2	28	41.8	12	18.5	12	18.5	62.6	18.5
H. S. 19 × Taihoku 6	62.4	22.8	7	31.9	20	57.4	18	21.5	18	21.5	55.4	21.5

(b) *Within indica group of rices.*—This breeding project, as previously reported, has been undertaken to evolve early maturing, high yielding strains. During the year the performance of 243 cultures in the F_5 generation belonging to 8 cross combinations, involving three early varieties (CH 2, *Sathika* and T. 1031) and four late varieties, (T. 90, T. 812, T. 1145 and T. 1241) was studied in a randomised replicated layout with 5 replications. While the flowering duration of the high yielding late parents ranged from 110–130 days, the F_5 cultures flowered within 100 days of sowing, 43 of them being as much as 30 days earlier in maturity. With regard to yield it was found that:

(i) All the cultures were significantly superior in yield to the 3 early maturing parents but inferior to Type 90, and Type 1242, the two best late maturing parents. However, 151 cultures were as good as T. 1145 and T. 812 (140–145 days duration) one of which, progeny 243, was actually superior to T. 1145 and T. 812. All the above 151 cultures were 121 days in duration.

(ii) The selections from the cross combinations of T. 90, T. 1031 and *Sathika* were mostly fine-grained. One hundred and thirtynine single plant selections made from the most promising cultures have been carried forward for further study. The performance of 25 best cultures is given in Table XVI below:

TABLE XVI—Early $\times$ High yield F_5 cultures, 1954-55

Progeny	Cross	Plot yield (gm.)	Flowering duration (days)	Grain quality
1	2	3	4	5
	T. 1242 (Parent)	852.5	130	Coarse.
	T. 90 (Parent)	740.7	120	Fine.
243	T. 812 $\times$ T. 1031	598.67	106	Broad.
234	T. 90 $\times$ <i>Sathika</i>	566.63	104	Fine.
198	T. 1242 $\times$ T. 1031	561.52	100	Broad.
212	T. 90 $\times$ T. 1031	560.96	98	Very Fine.
111	T. 1145 $\times$ T. 1031	560.11	95	Medium.
199	T. 1242 $\times$ T. 1031	557.24	95	Medium.
86	T. 1145 $\times$ CH 2	556.99	98	Broad.
43	T. 1145 $\times$ <i>Sathika</i>	548.48	94	Medium.
58	T. 1145 $\times$ <i>Sathika</i>	545.07	91	Medium.
84	T. 1145 $\times$ CH. 2	540.25	95	Broad.
5	T. 1145 $\times$ <i>Sathika</i>	537.98	93	Medium.
182	T. 1242 $\times$ <i>Sathika</i>	537.13	97	Long.
99	T. 1145 $\times$ 1031	535.15	97	Long.
134	T. 1145 $\times$ T. 1031	530.33	94	Med. Long.

1	2	3	4	5
87	T. 1145 × CH 2	525.79	95	Broad.
178	T. 1242 × <i>Sathika</i>	521.25	100	Long.
242	T. 90 × <i>Sathika</i>	520.68	94	Very Fine.
95	T. 1145 × T. 1031	515.01	99	Med. Long.
98	T. 1145 × T. 1031	515.01	99	Long.
145	T. 1145 × T. 1031	513.59	94	Med. Long.
207	T. 90 × T. 1031	513.59	93	Fine.
10	T. 1145 × <i>Sathika</i>	512.74	90	Med. Long
18	T. 1145 × <i>Sathika</i>	508.49	91	Med. Long.
26	T. 1145 × <i>Sathika</i>	507.36	93	Med. Long.
93	T. 1145 × <i>Sathika</i>	506.5	98	Med. Long.
	T. 1145 (Parent)	502.25	110	Coarse.
	T. 812 (Parent)	484.10	114	Very fine.
	<i>Sathika</i> (Parent)	196.25	78	
	T. 1031 (Parent)	162.50	68	
	CH 2(Parent)	82.24	69	
	C.D.	82.81		

III. Breeding for High Fertility Soil Conditions

Investigations are in progress to determine suitable varieties for cultivation under heavily manured conditions. Last year 64 varieties were tried, and this year 60 varieties were tested in 3 trials according to duration under 3 levels of fertilization., (1) no manure; (2) normal (40 lb. nitrogen given as 100 lb. ammonium sulphate and 4,000 lb. green matter plus 18 lb. P_2O_5 as super phosphate per acre) and (3) heavy (120 lb. N, given as 400 lb. of ammonium sulphate and 8,000 lb. as green matter plus 54 lb. P_2O_5 per acre).

As in last year, a depression in yield was noticed this year also under heavy fertilization and there was no interaction between varieties and levels of manuring. In the above trials 40–120 lb. N per acre was applied while under Cuttack conditions the optimum dose of nitrogen application appears to be about 30-40 lb. per acre.

IV. Breeding for non-lodging habit

Lodging is a serious handicap in Indian rice varieties, which are generally weak strawed and are prone to lodge under heavy manuring, resulting in considerable loss in yield. A project has therefore been initiated for breeding high yielding, non-lodging strains. During last year's trial with 16 varieties from genetic stocks, three were found to be non-lodging under heavily manured conditions. These varieties were again tested this year along with seven new varieties brought forward from genetic stocks, under high level of fertilization (120 lb. of nitrogen as 400 lb. of ammonium sulphate and 8,000 lb. of green matter and 54 lb. P_2O_5 as super phosphate). Four varieties, viz., AC. 517 from U.P. and the 3 varieties of last

year remained non-lodging. These 3 varieties, *Puangnak*, *Nam-dok-mai* and A.C. 1951, are not suited for local conditions and are being exploited as parents for breeding non-lodging strains.

V. Breeding for upland conditions

The performance of 48 short duration varieties (82—108 days) along with the 2 standards, *Benibhog* and B. 76—116, was tested for cultivation under purely rainfed conditions. Though none of the varieties yielded significantly more than the controls, it was found that eight of the varieties were as good as controls and their yield ranged from 1754 to 2044 lb. per acre.

VI. Breeding for disease resistance

As mentioned last year, work in collaboration with the Mycologist has been started for breeding high yielding, early and medium duration strains resistant to blast and helminthosporium, the two most important diseases of the rice crop.

During the year, the F_1 generation of the cross between Co. 25, a late duration strain resistant to blast and Co. 13, an early maturing strain very susceptible to blast, was studied. Under natural infection in the nursery, resistance to blast disease appeared to be dominant. Crosses were made between Co. 25 and BAM. 10 (resistant to helminthosporium,) for evolving strains resistant to both the diseases.

VII. Breeding for Fine Quality

In view of the demand for fine table rices, a collection of *basmati* rices from various sources has been made. The collection was studied and 306 field selections based on grain character and tiller number were made.

The field selections were further examined and based on single plant yield, 95 selections were retained for further study.

VIII. Secondary Selection

This investigation, as previously reported, is in progress to study the value of secondary selection in rice breeding. Results obtained in the previous years indicate that there is scope for further selection in the progenies of selections previously made. It was reported last year that significant differences in yield were found between the primary selections made in the variety, *Saruchina*. Secondly, selections in the 15 best progenies were tested in a compact family layout with 6 progenies in each family. Significant differences in yield were found between the families and in four families i.e., nos. 409, 322, 199 and 159 significant differences in yield were found

between the progenies. Within family data of these four families are given below:

Within family comparison:

Family 159

Progenies

	7	9	10	8	11	12	C.D.
Mean yield (oz.)	25.64	24.77	24.74	23.58	22.47	22.32	1.86

Family 199

Progenies

	22	20	24	21	23	19	C.D.
Mean yield (oz.)	25.81	25.24	24.30	23.58	23.22	21.92	1.05

Family 322

Progenies.

	45	44	47	46	48	43	C.D.
Mean yield (oz.)	26.02	25.16	24.42	24.35	23.42	22.47	1.95

Family 409

Progenies

	76	78	77	73	74	75	C.D.
Mean yield (oz.)	27.46	27.07	25.18	24.27	23.86	22.48	2.48

IX. Genetics

Spikelet Sterility.—As reported last year variability for sterility in the F_3 generation of *japonica* × *indica* crosses was found to be continuous except in a few families which segregated sharply into fertile and sterile plants. In the progenies showing continuous variation, the range of variation was either wide or restricted. The F_4 generation was studied during the year and the behaviour of the cultures is given below:—

1. Cultures from sharply segregating F_3 s:

(i) Cultures from fertile segregates bred true.

(ii) Cultures from sterile parents showed sharp segregation for fertile and sterile plants.

2. Cultures from F_3 Families with restricted variation:
 - (i) Cultures from fertile segregates bred true.
 - (ii) Cultures from sterile segregates bred true.
3. Cultures from F_3 families with wide segregation:
 - (i) Cultures from fertile parents bred true.
 - (ii) Cultures from medium sterile parents showed wide variation like the P_3 .
 - (iii) Cultures from highly sterile parents either bred true or showed a wide variation as the F_3 or showed a restricted variation with the range of variations towards greater fertility.

Pigmentation.—In the investigation of inheritance of anthocyanin pigmentation in rice and the inter-relationship of the genes concerned, the F_3 generations of 15 *japonica*—*Indica* crosses, involving 14 *indica* and 6 *japonica* parents were studied for occurrence of pigmentation in 11 plant parts viz., leaf sheath, leaf axil, leaf tip and margin, ligule, auricle, junctura, apiculus, stigma, glumes, internode and septum. The inheritance of anthocyanin pigmentation in the different plant parts was found to be controlled by one to four genes and different ratios of pigmented: non-pigmented were obtained in different crosses with respect to a particular plant part. The ratios obtained in the individual plant parts are given below:

Plant organs	Ratios obtained
Leaf sheath	3:1, 9:7, 27:37, 54:10, 45:19, 162:94, and 81:175.
Leaf axil	In this plant part pigmentation followed the pattern found in the leaf sheath.
Leaf tip & margin	9:7, 81:175, 117:139.
Auricle	} In these three plant parts pigmentation followed the same pattern found in leaf-tip and margin.
Ligule	
Junctura	
Glumes	27:37 and 162:94.
Stigma	3:1, 9:7, 27:37, 45:19 and 162:94.
Internode	9:7, 27:37, 81:175, and 162:94.

It would be thus seen that in all, the following 8 different ratios of pigmented: non-pigmented were obtained (1) 3:1, (2) 9:7, (3) 27:37, (4) 45:19, (5) 54:10, (6) 81:175, (7) 162:94, (8) 117:139.

The joint segregation of pigmentation in two plant parts showed that the inheritance of pigmentation in any part was not independent of that in any other plant part studied.

Since two phenotypes were obtained in the segregation of pigmentation in individual plant part, four classes are to be expected in the joint segregation of pigmentation in two plant parts, but in most cases it was found that one of the recombination classes was missing, and the data in such cases could be explained on the basis of pleiotropy. As for example in the cross *Zuiho* × *Marichbuti* the segregation of pigmentation in leaf-sheath was in the ratio 45 pigmented : 19 non-pigmented and that in apiculus 3:1, while the joint segregation of pigmentation was in the ratio of 45:0:3:16 as given below:

	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>	<i>Total.</i>
Observed	417	0	29	148	594
Expected (45:0:3:16)	17·7	0	27·8	148·9	594

The above data agree with the expectation on the basis of pleiotropy.

While in most cases pleiotropy was found, the data in some instances, however, showed linkage between the pigmentation genes of stigma and internode, stigma and septum and internode and septum. In some of the crosses the crossing over percentage could not be determined due to the complex ratios like 162:94 governing the segregation of pigmentation in the individual parts concerned.

The F_1 generation of the crosses between the faint purple wash leaf blade (a mutant leaf blade type isolated from a purple wash leaf blade culture) and dark purple leaf blade type, between the mutant and purple wash, and between the mutant and pure green type, was studied. The leaf blade colour of the hybrids of all these crosses was found to be dilute purple wash, but deeper in pigmentation than the mutant type. The material is being carried forward for study of the generation.

Physiology

Photoperiod response of rice varieties.—The response of 20 varieties from eight Asian countries, viz., Burma, Ceylon, India, Indonesia, Malaya, Pakistan, Thailand and Vietnam to photoperiods of $10\frac{1}{2}$, $11\frac{1}{2}$, $12\frac{1}{2}$ hours and natural day length was investigated for the third year. Results confirmed those obtained in the previous years. None of the varieties tested, whether early or late in duration, were insensitive to photoperiod treatment; in general the varieties tended to flower earlier with the decrease in photoperiod. As reported last year the varieties *Book*, *Gendjahratji* and *Brondolputih*, all from Indonesia, did not flower under $12\frac{1}{2}$ hours photoperiod this year also. In the case of varieties, *Ravang* from Vietnam

and *Kohumawai* from Ceylon subjected to 12½ hours photoperiod, the controls flowered earlier than the treated plants. This was due to the natural day length being less than the photoperiod.

Ear emergence, commencement and completion of blooming, length of panicle, number of ear bearing tillers and plant height in the various treatments were recorded.

CHEMISTRY

I. Investigations on nitrogen transformation in wet rice soils.

(a) *Mineralising action of lime on soil nitrogen*

Investigations on nitrogen transformation and its availability to crop under the water-logged state of soil were continued. Preliminary laboratory studies conducted last year had shown that more nitrogen could be made available for crop utilization by application of lime to the water-logged soil. Field trials to confirm these findings were therefore undertaken. The effect of high doses of lime on availability of nitrogen, growth and yield of the crop was evaluated. These trials were located both in low land, poorly drained soil of low fertility and in medium land, well drained soil of good fertility. Periodical examination of soil for nitrogen status showed that after application of lime, NH_4N status of treated plots increased considerably at both locations. The yield increase was however, observed only under low land soil condition, where the additional available nitrogen due to lime application had beneficial effect on growth of the crop, resulting in more ear-bearing tillers per plant, increase in height, and higher yield of both grain and straw *vide* Table XVII below:

TABLE XVII—Effect of lime application on nitrogen availability and yield of crop

Medium land—good drainage				Low land—poor drainage			
Variety—T. 1145				Variety—T. 1242			
NH ₄ -N in soil p.p.m. after days of planting	Grain yield in lb/ acre	NH ₄ -N in soil p.p.m. after days of planting		Mean ear- head per plant	Mean Ht. in cm.	Grain yield in lb/ acre	Straw in lb/ acre
		10 days	60 days				
No lime	.	.	.	.	7.1	95.3	3559 (100)
	.	.	.	.	12	24.20 (100)	4328 (122)
Lime 2000 lb. per acre at planting	.	.	.	.	8.6	100.0	2880 (119)
	.	.	.	.	30	27	3559 (100)
Lime 2000 lb. per acre 3 weeks after planting	12	60	3938 (100.2)	24.20 (100)	7.1	95.3	3559 (100)

The medium land soil had already a high nitrogen status and therefore the extra nitrogen released in the soil did not give a corresponding increase in growth and yield. The additional mineralised nitrogen available under low land condition with lime application was equivalent to about 30 lb. N/acre applied as artificial fertilizer.

(b) *Effect of soil drying on nitrogen availability and crop yield*

Effect of soil drying prior to cultivation, on nitrogen availability in soil and growth and yield of crop was investigated. During the second crop season, a manurial trial was laid out in an area which had been continuously water-logged from the main crop season. Crop in this trial showed a stunted growth, poor tillering and stand and did not respond to nitrogen application. Soil examination from this area showed poor nitrogen status and low phosphate availability. The ammonification studies of soil from the area were conducted and the results showed that the wet soil was not capable of ammonifying soil organic nitrogen and make it available to the crop. The continuous water-logging had also brought about acute reduced conditions in the soil. The soil from these fields when aerated, air dried and again water-logged, produced far more $\text{NH}_4\text{-N}$ than the wet soil without drying.

Pot culture studies were undertaken with both wet and air dried soil from the same fields and nitrogen availability and plant growth in the two series were studied. Results are given below:

Treatment	$\text{NH}_4\text{-N}$ in soil 14 days after incubation at 35° C.	Mean earheads per plant	Mean No. of set grains per panicle	Grain yield per plant
Wet series	20	7.6	55	11.3 gm. (100)
Dry series	48	11.0	63	20.0 gm. (177)

Results bring out the importance of soil drying and soil aeration before cultivation for successful crop growth in intensive cultivation, particularly in regions where two or three crops are grown in succession.

II. Placement trials with nitrogenous fertilizers.

(a) *Sub-surface placement of sulphate of ammonia*

Field trials to see the effect of sub-surface placement of sulphate of ammonia as a fertilizer have been in progress since 1950. During this year, the nitrogen availability of the soil was measured in the trial in two stages of crop growth to investigate the availability of nitrogen in soil with different methods of fertilizer

application. Sub-surface placement showed a higher ammoniacal nitrogen in soil than surface application, throughout the active growth period of the crop and thus had a beneficial effect on the growth and yield of crop. The results of soil analysis are presented in Table XVIII below:

TABLE XVIII— $\text{NH}_4\text{—N}$ Status of soil with different modes of sulphate of ammonia fertilizer application.

Results expressed as p.p.m. on dry soil

Treatment	Days after planting	
	30 days	60 days
1. Control	12	10
2. 20 lb. N surface applied one month after planting	15*	17
3. 20 lb. N deep placed at planting	20	19
4. 20 lb. N deep placed one month after planting as pellets	15*	22
5. 20 lb. N deep placed at planting—10 lb. N deep placed one month after planting	22	25

*Soil sample for examination was taken prior to fertilizer application.

The yield data for the 5 years, during which the work has been in progress are summarised in Tables XIX and XX below.

TABLE XIX—Main season crop. Yield in lb. per acre with different modes of sulphate of ammonia fertilizer application

Treatment	1950-51	1951-52	1952-53	1953-54	1954-55
	Co. 13	T. 90	T. 1242	T. 141	T. 141
1. Control	1747 (100)	2541 (100)	2639 (100)	2579 (100)	2930 (100)
2. 20 lb./N surface application 3-4 weeks after planting	1882 (108)	2676 (105)	2797 (106)	2795 (107)	3100 (106)
3. 20 lb./N deep placed at planting	..	..	..	3011 (117)	3296 (112)
4. 20 lb./N deep placed 3/4 weeks after planting as pellets	2009 (115)	2768 (109)	2956 (112)	3191 (124)	3200 (109)

TABLE XX—Second season crop. Yield in lb. per acre with different modes of sulphate of ammonia fertilizer application

Treatment	1950-51	1951-52	1953-54
	Co 13	CH. 47	PTB 10
1. Control	1402 (100)	1222 (100)	1697 (100)
2. 20 lb./N surface applied 3-4 weeks after planting	1513 (108)	1290 (105)	1896 (112)
3. 20 lb./N deep placed at planting	..	..	2125 (125)
4. 20 lb./N deep placed 3 4 weeks after planting as pellets	1781 (127)	1500 (122)	2110 (124)

(b) Urea sub-surface placed in soil and sprayed on the standing crop.

The relative efficiency of urea and ammonium sulphate in increasing the yield was studied in a trial with a long duration variety, BAM. 9, with the following treatments:

- (1) urea sub-surface placed at 20 lb. N/acre, three weeks after planting.
- (2) Ammonium sulphate sub-surface placed at 20 lb. N/Acre, three weeks after planting.
- (3) Urea at 5, 10, and 15 lb. respectively, in 100 gallons of water sprayed on the crop prior to heading.
- (4) Control.

Results showed that urea, sub-surface placed at 20 lb. N per acre, was as efficient as sulphate of ammonia deep placed on equal nitrogen basis both giving significant yield increases of 10% and 8% respectively, over a control yield of 3759 lb. per acre. Urea at 15 lb. per acre sprayed at heading, gave a small increase in yield of 200 lb. per acre, being 5% increase over control yield. Increase in protein content of grain (control, 7.75%; sulphate of ammonia, 8.25%; urea, 8.31%; urea sprayed, 8.00%) was also obtained both with sulphate of ammonia and urea applications.

III. Phosphatic manurial trials

To study the cumulative effect of phosphatic fertilization on growth and yield of rice crop phosphatic manurial trials, which have been in progress for the last few years, were continued. Under low land field conditions, where super-phosphate at 50 and 100 lb. P_2O_5 per acre is being continuously applied for last three years, a small increase in yield was obtained during the current year with phosphate application. In pot experiments *in situ*, where similar dressings have been continued for last five years, a similar trend in yield increase was observed and 100 lb. P_2O_5 per acre gave a significant yield increase of 13% over control yield of 140 grams per pot.

IV. Advantage of saline separation of seed for sowing

In the Japanese method of rice cultivation, stress is being laid to separate out under-developed and shrivelled seeds by saline solution so that healthy and heavy seeds are obtained which germinate quickly. About twelve varieties of different durations were tested for amount of under-developed seeds by saline separation and its subsequent effect on germination was studied. The results are given in Table XXI below:

TABLE. XXI.—*Improvement in germination of seed after saline separation.*

Variety	% Germination before separation	% Germination after saline separation
N. 136	76	91
PTB. 10	78	88
B. 76	73	95
CH. 47	97	99
T. 1145	91	98
T. 56	87	95
Siam. 3	89	96
T. 90	92	99
T. 1242	72	96
F.R. 43B	95	96
BAM. 9	60	80
BAM. 6	94	99

Almost all the varieties that were tested had under-developed and shrivelled seeds to the extent of 6-12% by weight. These under-developed seeds either failed to germinate or germinated slowly and latter failed to produce sufficient growth. The germination of most of the varieties was improved to the extent of 10-12 % by saline separation. The seedlings obtained from the heavier seeds were healthy and showed a better stand. Results show the importance of saline separation of seed before sowing, in paddy cultivation practice, particularly where stress is laid on use of low seed rate to obtain healthy and vigorous plants for transplanting.

ENTOMOLOGY

A. FIELD PESTS

I. Varietal susceptibility investigations

(a) *Gallfly* (*Pachytiplosis oryzae* W.M.—Mani).—Examination of varieties from the Genetic Stock collection of the Institute was continued to determine their relative susceptibility to pests in general and gallfly in particular.

No pest incidence was observed in the nursery excepting a few leaf hoppers and leaf miners.

In the transplanted crop, 192 early maturing varieties were examined at the peak period of incidence of gallfly (last week of September). Distinct varietal reactions were observed; the incidence of gallfly ranged from 0.0 per cent. in variety PTB.2, to

63.6 per cent. in variety *Patnai 26* (Gosaba). The frequency table of percentage incidence is given below:

Percentage incidence	Number of varieties
0.0	1
0.1 to 5.0	13
5.1 to 20.0	112
20.1 to 40.0	56
40.1 and above	10
	192

(b) *Stemborers* (*Schoenobius incertulas*, Wlk., *Chilo* sp. etc.).—The reactions of 108 *dalua* or summer varieties to stemborers were studied by examination of random samples at the ear head stage of the crop. The percentage of white ear heads due to stemborers ranged from 0.0 in Co. 21 to 72.7 in Blue Bonnet-50. The frequency table of percentage incidence is given below:

Percentage incidence	Number of varieties
Below 1.0	3
Above 1.0	6
Above 10.0	30
Above 20.0	59
Above 40.0	10
	108

II. Incidence of pests in relation to Agronomic practices

An investigation is in progress since 1949, to determine the factors that are favourable for the prevalence and abundance of pests and to study the relationship between the incidence of pests and the season, time of planting and the age of the crop.

In this experiment 30 days old seedlings of two varieties, viz., Ch. 45 and D.I.4, are planted at fortnightly intervals, from July to March and the prevalence of pests estimated by examination of random samples drawn from the different plantings when the crop is 60 and 90 days old and at harvest. The results obtained this year are discussed below:

(a) *Gallfly*.—Gallfly incidence started in the middle of August, 1954 (3.93%) and continued till the middle of January, 1955 (5%). The peak period of infestation was observed to be from the middle of September to the middle of October (43.04%). There was a decrease in the incidence in November (26.54%) with a further increase during December (33.83%). As in previous years, 90 days old plants were found to be more susceptible than 60 days old plants irrespective of the time of planting. During this year the highest percentage of natural parasitisation of gallfly grubs was during September-October (81.4%).

(b) *Stemborers*.—Incidence of stemborers started in the month of November (0.5%) and continued till April. Moth population in the field, as judged by catches at light trap, was the highest during the 4th week of February. This incidence resulted in white ear heads in the plantings done in December-January and in deadhearts in the plantings done in February.

III. Insecticidal Trials to Control Pests

1. *Efficacy of different insecticides in the control of pests of paddy*: (a) *Gallfly*.—The comparative merits of four organophosphorous insecticides (Folidol-E 605 E.C., Systox E.C., Ekatox-20 E.C., and EPN-300 W.D.) and three chlorinated hydrocarbons (Hortex E.C., Endrin 19.5% E.C. and Gammexane E.C.) in controlling gallfly were investigated in an experiment with the variety GEB.24.

The treatments included: (i) soaking the seeds in the solution of respective insecticides; (ii) soaking the seeds in and irrigating the nursery with the respective insecticides; (iii) dipping the seedlings for 6 hours in the insecticidal solution prior to transplanting; (iv) post-transplanting sprayings with respective insecticides according to the prevalence of the pest; and (v) control.

Examination of random samples taken at the peak period of incidence of gallfly revealed, that under the treatment namely, soaking the seeds in and irrigating the nursery with the respective insecticides, the organophosphorous insecticides were more effective than the chlorinated hydrocarbons in reducing the incidence of gallfly. The efficacy of post-transplanting sprayings was in the following descending order: Folidol, Hortex, Endrin, Systox, Ekatox, Gammexane and E.P.N. 300.

(b) *Stemborers*.—A similar experiment to study the comparative merits of the above mentioned insecticides to control stemborers was conducted with variety, PTB 10, in the *Dalua* season.

In addition to the insecticides mentioned above, one more organo-phosphorous insecticide, Basudin 20% EC, was also included for trial.

Examination of random samples at the time of harvest indicated that the organophosphorous insecticides were more effective than the chlorinated hydrocarbons in general. The efficacy of post-transplanting spraying was in the following descending order: E.P. N.300, Folidol, Basudin, Systox, Endrin, Ekatox, Gammexane and Hortex.

2. *Efficacy of different methods of application of Folidol-E 605, in the control of rice pests: (a) Gallfly.*—An experiment was conducted to find out the most efficient method of application of Folidol to control gallfly in rice. The treatments, as given in Table XXII below, were tried in the experiment with the variety, GEB.24.

TABLE XXII—Percentage Incidence of Silvershoot and Yield

	Treatments	Mean% infestation	%Decrease over check.	Yield in lb/acre.	%Increase over control
T ₁	Check or Control.	17.30	..	3103.50	..
T ₂	Soaking seeds in 0.1% Folidol for 24 hours.	16.20	6.33	3157.97	1.76
T ₃	T ₂ +Irrigation in nurseries twice with 0.1% Folidol.	16.04	7.24	3025.17	—2.52
T ₄	T ₂ +Irrigation in the transplanted crop every 10th day (5 times in the season).	6.77	60.85	3573.84	15.16
T ₅	T ₂ +Spraying the transplanted crop with 0.08% Folidol twice to syn- chronise with the pest population on the field.	12.76	26.21	3249.98	4.82
T ₆	T ₂ +Spraying the transplanted crop 9 times at intervals of 10 days till flowering.	9.03	47.80	3569.11	15.00
T ₇	Dipping the uprooted seedlings (roots and foliage) in 0.1% Folidol for 6 hours prior to planting.	14.14	18.32	3073.32	—0.97
T ₈	Spraying only the transplanted crop with 0.08% Folidol as in T ₅	18.23	+5.38	3210.54	3.45
T ₉	Both treatments as in T ₇ and T ₈	15.14	11.89	3299.08	6.30
	C.D.(0.05)	5.73		270.66	

Random samples were uprooted and examined at the peak period of incidence of gallfly to note the efficacy of the different treatments. It may be seen from the table XXII that treatment No. 4 and treatment No. 6 were very effective in controlling gallfly incidence and there were significant increases in yield.

Folidol—E 605 is reported to be toxic to man by "contact, ingestion or inhalation". The grain and straw samples of the treated plants were therefore analysed at the Central Food Technological Research Institute, Mysore, through the kind courtesy of the Director to find out whether the toxic effects of the insecticide would persist in the grain and straw samples of the treated plants. According to the report received from Mysore, no toxic residue of the chemical or any other harmful metabolite, was present in or on the grain and straw samples, obtained from the crop treated with Folidol.

(b) *Stemborers*.—A similar experiment to the above was carried out in the second crop season with the variety, PTB. 10, to find out the most effective method to control rice stemborers with Folidol—E 605. The data are presented in Table XXIII below:

TABLE XXIII—Control of Stemborers: Percentage of incidence of white ear heads due to stemborers and yield.

Treatments	Mean Percentage white earheads per unit sampling area of 1' × 1'	Per cent decrease over control.	Yield in lb/acre.	Per cent increase over control.
T ₁ . . .	20.48	..	1769.63	..
T ₂ . . .	18.54	9.47	1808.28	2.18
T ₃ . . .	17.82	12.99	1597.74	—9.71
T ₄ . . .	8.82	56.93	2441.72	37.98
T ₅ . . .	15.37	24.95	2125.91	20.13
T ₆ . . .	3.32	83.79	2729.76	54.26
T ₇ . . .	13.26	35.25	1636.95	—7.50
T ₈ . . .	11.69	42.92	2074.55	17.23
T ₉ . . .	12.11	40.87	1955.66	10.51
C.D. (.05).	5.741		329.79	

As in the case of gallfly, the treatment No. 4 and the treatment No. 6 were very effective and were associated with significant increases in yield.

The weight of 1,000 grains from healthy and partially chaffy ear heads was compared and the data are given in Table XXIV below:

TABLE XXIV.—Control of Stemborers: Mean weight of 1,000 grains of both healthy ear heads and partially chaffy ear heads due to Stemborers.

Weight of 1,000 grains in gm.			
Treatments.	Healthy earhead .	Partially chaffy earhead due to stemborers.	Treatment means
T ₁ . .	22.58	21.18	21.88
T ₂ . .	22.60	21.86	22.23
T ₃ . .	22.48	21.44	21.96
T ₄ . .	22.91	22.46	22.69
T ₅ . .	23.08	21.84	22.46
T ₆ . .	22.97	22.84	22.91
T ₇ . .	22.57	20.65	21.61
T ₈ . .	22.89	22.22	22.56
T ₉ . .	22.01	21.25	21.63
Mean. . .	22.68	21.75	
C.D. (0.05) to compare treatment means.			
C.D. (0.05) to compare healthy vs. attacked.			
C.D. (0.05) to compare interaction			
			0.365
			0.172
			0.516

It was seen that in all cases, except T₄ and T₆, the weight of 1,000 grains from healthy ear head was significantly more than that of 1,000 grains from partially chaffy ear-heads. The difference between T₄ and T₆ was not significant; this may be attributed to the fact that the attack of stemborer began after the milk stage of the grain resulting in only a few ill-formed grains.

IV. Estimation of Loss in Yield due to Pests.

(a) *Gallfly*.—The data collected from the experiment III (2a) described above were utilised to estimate the loss caused by gallfly. Regression function of plot yield on the estimated percentage incidence of gallfly is given below:

$$Y = 4720.18 - 23.71X$$

where 'Y' is the expected yield in pounds per acre and 'X' is the percentage of incidence of gallfly. The regression coefficient was found significant, indicating thereby that a significant part of the total variation in plot yield is accounted by the linear effect of gallfly incidence. It was seen that for every unit per cent increase in the incidence of gallfly, there was a loss of 0.502% in this experiment which worked out to 23.71 lb. per acre.

(b) *Stemborers*.—In the case of stemborers also, the regression function of plot yield on estimated percentage of white ear heads was calculated from the data collected in the experiment III (2b) described above. The regression equation is given by,

$$Y = 2197.97 - 13.27X$$

where 'Y' is the expected yield in pounds per acre and 'X' is the percentage incidence of white ear heads per sampling basis. It was noticed from the above regression that for every unit per cent. increase in the white ear heads due to stemborers, the loss was 0.604% which worked out to be 13.27 lb. per acre.

V. Efficacy of Low Volume Spraying

In an experiment to study the relative efficacy of spraying Folidol-E 605 with a low volume nozzle and the ordinary nozzle, it was found that the incidence of gallfly was reduced by 29.8 per cent over control with low volume spray nozzle while it was reduced by only 13.6 per cent with ordinary nozzle.

VI. Occurrence and Control of other Field Pests

(1) A light trap was set up every night in the field for one hour throughout the year to determine the abundance of pests, particularly stemborers, gallfly and leafhoppers. On the basis of the insect catches at the light trap, the time of emergence of fresh broods of insects and their duration were determined and pest control measures on the whole farm were scheduled accordingly to control the pests. The emergence of broods is being correlated with meteorological factors prevailing at that time with a view to determine the factors favourable for pest emergence and ultimately to forecast the pest outbreaks.

(2) *Rice caseworm* (*Nymphula depunctalis*, Gn.)—This pest was prevalent in October especially in water-logged low lying plots. Although dusting the crop with 5 per cent BHC controlled the pest, spraying with 0.1 per cent Folidol was more effective. In either case water was drained off 24 hours after treatment.

(3) *Rice Root aphid* (*Tetraneura hirsuta*, B).—A copious spraying with 0.08 per cent Folidol especially on the soil surrounding the plants, effectively controlled the pest.

(4) *General pest control*.—About 5 acres of experimental plots and 1.5 acres in the intensive cultivation area were sprayed with 0.08 per cent. Folidol to control gallfly, leaf hoppers and thrips.

B. Laboratory Experiments

Laboratory trials with Basudin 20 per cent EC and Folidol-E 605 EC, proved that neither could act as effective ovicides for stemborer eggs when applied as spray at 0.03 per cent and 0.03 per cent concentration respectively, although the stemborer larvae died soon after hatching. However, the hatched larvae in seedlings irrigated with 0.03 per cent Basudin at weekly intervals died

shortly after boring into the sheath indicating thereby that the seedlings might have absorbed the active ingredient through the roots and translocated the same to the aerial parts of the plants. This needs to be confirmed.

C. Pests of Stored Grain

Efficacy of Prefabricated Aluminium Bin for bulk storage of paddy.—The efficacy of prefabricated aluminium grain storage bin and wooden bin for bulk storage of unhusked rice was compared. A quantity of 300 md. of paddy of variety, T.1242, was stored for 12 months in each bin and samples were drawn every month for recording the population of pests and the percentage moisture of grain. It was found that the infestation by the grain moth, *Sitotroga cerealella* was almost nil in the aluminium bin. The percentage of weevilled grain was 2.14 and 4.82 in the aluminium and wooden bins, respectively. But the viability of the grain inside the aluminum bin was adversely affected. At the termination of the experiment, the viability was 0.00 per cent in the aluminium bin as compared to 42 per cent in the wooden bin. The overall damage to grain due to insects was found to be 1.2 per cent in the aluminium bin and 1.8 per cent in the wooden bin.

It may therefore be stated that, though the aluminium bin may be good for storage of food grains it may not be suitable for seed storage.

MYCOLOGY

I. Study and estimation of resistance to diseases, particularly Blast and Helminthosporiose in the collection under Genetic Stocks

The reaction of the types in the genetic stock of Central Rice Research Institute to the diseases commonly occurring at Cuttack was studied. Observations on disease incidence were made on all the types in the seedling stage, but later observations were confined to early varieties in the collection. In the seedling stage there was no disease. In the adult stage, 16 of the early types were found susceptible to *Helminthosporium* disease and only one to blast.

The reaction of the early and medium duration types in the F.A.O. World Genetic Stock to these diseases was also studied. None of them had any disease in the seedling stage. In the adult stage, 14 of early and 34 of the medium duration types were found susceptible to *Helminthosporium*. None amongst the early types had an attack of blast. Amongst the medium duration types, blast was noticed on one type only. *Entyloma Oruzae* was noticed on one of the early duration types.

II. Helminthosporium Disease

(a) *Tests of resistance of selected varieties under natural and artificial infection.*—The performance of six varieties, Ch. 13, Ch. 45, T. 141, Co. 20, T. 498-2A and BAM 10, found resistant to moderately resistant for the last two years was tested under artificial infection in the field. Artificial infection was carried out twice on each variety, once in the seedbed before transplanting and again at the time of flowering of the respective varieties.

Observations on disease development were taken a week after the inoculation and the resistance of the varieties to the disease was confirmed.

(b) *Co-ordinated trial of selected resistant varieties in different States in India.*—Five of the resistant varieties (Ch. 13, Ch. 45, T. 141, T. 498-2A and BAM. 10) were tested in 25 centres distributed in the States of Uttar Pradesh, Bihar, West Bengal, Assam, Orissa, Andhra, Madras, Travancore-Cochin, Madhya Pradesh, Hyderabad, Coorg and Mysore. The test was carried out in collaboration with the State Departments of Agriculture. Along with these five varieties, a susceptible standard strain, *Benibhog* was included in the tests. Observations on disease incidence were recorded on samples received from the different centres at three stages viz., seedling stage, post-transplanting stage (one month after transplanting) and pre-harvest stage.

The disease did not occur in some of the centres; in others where the disease occurred, the varieties Ch. 13, Ch. 45 T. 141 and BAM. 10 behaved mostly as resistant to moderately resistant. T. 498-2A, was not uniformly resistant in all centres. The experiment will be repeated for 3-4 seasons to confirm the resistance of the varieties.

(c) *Artificial infection tests on early types in genetic stock for selection of resistant types.*—In the genetic stock collection at Central Rice Research Institute there are 490 types of early duration (upto 120 days). Of these 172 types were included in earlier tests and their reaction to Helminthosporium disease determined. From the remaining 318 types, 150 were taken up for artificial infection tests. Severe natural infection developed on the seedlings when they were a month old, before artificial infection could be done. Forty six varieties which were found resistant under these conditions, have been carried forward for further tests.

(d) *Identification and estimation of airborne conidia over rice fields.*—Exposing greased slides in aeroscopes once a week for determination of aerial population of conidia of *Helminthosporium*.

oryzae was continued throughout the year. The number of conidia of *Helminthosporium oryzae* and other fungi trapped in each week was counted. Meteorological data, such as relative humidity, minimum and maximum temperature and amount of cloudiness for the days on which the aeroscopic slides were exposed were collected side by side. As in previous year it was observed that the increase in spore catch in any week was associated with the increased humidity and cloudiness. Analysis of the last four years' data is now in progress.

III. Blast Disease

(i) Varietal susceptibility tests

(a) *Tests of resistance of selected varieties under natural infection in field experiments.*—18 Varieties selected as resistant and 19 moderately resistant in last year's trial were tested in a field trial under natural infection of blast in two replications. Each variety was sown in a small separate seedbed, and ammonium sulphate at the rate of 20 lb. N per acre was given about 15 days after sowing. Observations on disease incidence in seedbeds were taken just before planting. In the field the varieties were planted in two rows per plot each 20 ft. long and flanked on either side by two rows of a very susceptible variety, Co. 13. Ammonium sulphate at 30 lb. N per acre was applied about one month after planting. Observations on neck infection were taken shortly before harvest. The results showed that the following 14 varieties were resistant to moderately resistant.

Variety	Reaction to blast at Cuttack
1. B.J. 1	Resistant.
2. Sm. 8	Do.
3. Sm. 6	Do.
4. S. 67	Do.
5. Mtu. 5	Do.
6. C.P. 6	Do.
7. S. 624	Do.
8. A.K.P. 8.	Do.
9. A.K.P. 9.	Do.
10. Ch. 55.	Moderately Resistant.
11. H. 755	Do.
12. Sm. 9	Do.
13. C.P. 9	Do.
14. PTB. 10	Do.*

* (Found resistant in seedling and post-transplanting stages and susceptible at neck infection stage).

(b) *Co-ordinated trial of selected resistant varieties in different States in India.*—Four blast resistant strains, B.J.1. Sm. 8, Ch. 55 and PTB. 10 along with 2 resistant hybrids, T. 6517 and T. 6522, evolved in Madras State were included in the tests with Co. 13 as the susceptible standard. The test was carried out in 22 Centres in different States in collaboration with the State Departments of Agriculture. Observations were recorded at three stages, seedling stage, post-planting stage (one month after transplanting) and pre-harvest stage on samples received from different centres.

At the seedling stage the varieties remained resistant in all centres where the infection was seen but in Jeypore (Orissa) PTB. 10 was found susceptible and in Ollukara (Tranvancore-Cochin) B. J. 1 and T. 6522 were found moderately susceptible and Ch. 55, susceptible.

At the post-transplanting stage all the varieties except T. 6517 and T. 6522 were resistant to moderately resistant in all centres; T. 6517 was susceptible at Nagenahally (Mysore) and Ponnampet (Coorg) and T. 6522 was moderately susceptible at Ollukara (Tranvancore-Cochin). At the neck infection stage, all the varieties except PTB. 10 remained resistant at all centres; PTB. 10 was found susceptible at Cuttack. The trials are being continued to check the findings of this year.

(ii) *Control of blast by spraying*

(a) *Efficiency of different fungicides.*—Treatments consisted of four sprayings each of (1) Bordeaux Mixture 5-5-50, (2) Perenox 0.5 per cent (3) Coppesan 0.5 per cent, (4) Cupravit 0.5 per cent and, control (unsprayed). The experiment was carried out with variety, Co. 13. Sprayings were done on 22-9-54, 4-10-54, 12-10-54, and 19-10-54.

Observations on percentage of neck infection and yield were taken for each plot. Analysis of the data showed that all the four fungicidal treatments were associated with significantly lower percentage of neck infection and significantly higher yields than the control. The data are presented in Table XXV below:

TABLE XXV Yield per acre and percentage of neck infection obtained with different spraying treatment

	Bordeaux Mixture 5:5:50	Perenox 0.5%	Coppesan 0.5%	Cupravit 0.5%	Control	C.D. at 5% level
Yield per acre in lb .	1620	1482	1325	1536	1026	251.8
Percentage of neck infection .	9.07	11.71	13.10	7.75	29.61	
(Angular values) .	(17.15)	(19.88)	(20.88)	(15.63)	(32.91)	(4.00)

(b) *Effect of time and number of sprayings of Coppesan 0.5 per cent on the blast incidence and yield of rice.*—The treatments consisted of (1) four sprayings, two before and two after flowering, (2) two sprayings, one before and one after flowering, (3) two sprayings, both before flowering (4) two sprayings, both after flowering and (5) control (unsprayed). This experiment was also carried out with variety, Co. 13. Observations on the percentage of neck infection and yield per plot were taken in the same way as in the previous experiment.

Analysis of the data showed that all the treatments gave significantly higher yields and significantly lower percentage of neck infection than the control. The treatment, four sprayings, two before and two after flowering, was the best and two sprayings both before flowering was next in order. There was no difference between the other two treatments. The data are presented in Table XXVI below:

TABLE XXVI.—*Effect of number and time of spraying on neck infection and on yield in Variety Co. 13.*

	4 sprayings, 2 before & 2 after flowering	2 sprayings, 1 before & 1 after flowering	2 sprayings, both before flowering	2 sprayings, both after flowering	Control (unsprayed)	C.D.(5%).
Yield per acre in lb.	1828	1458	1667	1424	1175	160.09
Percentage of neck infection.	12.25	18.50	13.54	18.46	32.07	
(Angular values)	(19.84)	(24.82)	(21.30)	(24.99)	(33.95)	(4.38)

(c) *Estimation of loss in yield caused by blast.*—Data from the previous experiment were utilised for the estimation of loss caused by blast. Correlation between the percentage of neck infection and yield per plot as well as per sample was determined. The regression of yield on percentage of neck infection was found to be linear. From the regression equation, the estimate of loss in yield for every increase of one per cent of neck infection was found to be 0.43 per cent as estimated from plot yields and 1.3 per cent as estimated from sample yields.

(d) *Efficiency of low volume spraying.*—The relative efficiency of low volume spraying and normal spraying was investigated with the following treatments on variety, Co. 13, (1) 4 sprayings, two before and two after flowering with pressure retaining Knapsack sprayer using ordinary nozzles: spray fluid used, Coppesan 0.5 per cent at the rate of 100 gallons per acre for each spraying, (2) similar

number of sprayings with low volume nozzle at 20 gallons of spray fluid per acre and (3) control (unsprayed). The sprayings were done on 10-9-54, 23-9-54 30-9-54 and 9-10-54. Observations on neck infection were taken just before harvest and yields of plots were recorded.

Analysis of the data showed that both normal and low volume sprayings gave significantly higher yields and significantly lower percentage of neck infection than control. The two treatments, i.e., normal spraying and low volume spraying were not significantly different from each other as regards yield and neck infection. The data are given in Table XXVII below:

TABLE. XXVII.—Yield in lb. per acre and percentage of neck infection obtained with normal, and low-volume spraying

	Normal spraying	Low volume spraying.	Control(unsprayed)	C.D.(5 %)
Yield per acre in lb.	1897	1821	1470	125.40
Percentage of neck infection	4.30	11.20	29.60	
(Angular values) . . .	(11.78)	(18.45)	(32.39)	(7.78)

The cost of low volume spraying applied four times comes to Rs. 10-12-0 per acre, and this has given an increased yield worth Rs. 30 while the cost of 4 normal sprayings is Rs. 54 per acre.

IV. Seed Treatment of Rice with Fungicides

A field experiment on the seed treatment of rice for control of primary infection of *Helminthosporium* disease with four seed-dressing fungicides, i.e., (1) Agrosan GN, (2) Special Agrosan of low volatility (3) Fernasan A and (4) Copper seed dressing Y.F. 2776, was conducted during the year. The variety *Benibhog*, very susceptible to *Helminthosporium* disease, was used. Seeds treated with the four fungicides were sown in the nurseries together with an untreated control series in a 5×5 latin square design. Observations on stand and disease incidence in five sample areas of 6"×6" were taken per plot. Seedlings were transplanted in a 5×5 latin square, the size of unit plot being 42 ft. x 7.5 ft. Disease incidence at the adult stage was noted with reference to a standard chart. Yields of individual plots were noted.

Analysis of the data showed that none of the treatments showed any significant differences with control as regards leaf infection in mature plants and yield. There was very little disease incidence in the seedbed.

FARM & MISCELLANEOUS

I. Multiplication of Improved Strains of Paddy.

During the year, 2459 md. of seed of the more popular strains of Orissa State was produced for distribution.

II. Maximum Potential Experiment

This is a permanent experiment, now in progress for 6 years, to determine the extent to which yield of rice could be stepped up by adopting all the departmental recommendations (manurial and cultural). During this year a block of 4.93 acres was cropped with T. 1242. The manures applied were (5,000 lb. of green manure *dhaincha* grown *in situ* and buried), supplemented with 50 lb. of ammonium sulphate (10 lb. of N). Super-phosphate at the rate of 80 lb. per acre was applied to field at the time of sowing of the green manure crop. An average yield of 3461 lb. of grain per acre was obtained as against the yield of 3313 lb. obtained under this experiment in 1953-54.

A steady increase in yield per acre has been obtained in the experiment from 2541 lb. in 1949-50 to 3461 lb. per acre in the year under report as will be seen from Table XXVIII given below:

TABLE XXVIII—Mean yield of grain in lb. per acre

Year	1949-50	1950-51	1951-52	1952-53	1953-54	1954-55
Variety	T.90	T.1242	B.A.M. 9	T.1242	B.A.M.9	T.1242
Yield	2541	2474	3005	2734	3313	3461

The fertility status of the soil appears to be steadily built up under the above conditions.

III. Cultural Trials

(1) Comparison of dibbling, broadcast sowing of sprouted seed in puddle, and transplanting

The effect of the three practices mentioned above on the yield of crop was studied with the two varieties, T. 141 and T. 1242. The result showed that by transplanting the best yield was obtained. In the case of variety, T. 1242, dibbling also gave as good a yield as transplanting. Sowing sprouted seeds was inferior to transplanting.

(2) Effect of seed bed practices on yield of crop

The effect of three methods of raising seedlings namely, (1) the Japanese method, (2) dibbling seed in the plough furrows and (3) customary practice of dry sowing, on the yield of the crop was investigated. It was found that there was practically

no difference between the treatments with regard to the ultimate grain yield.

(3) *Effect of ridging on yield of crop*

In this experiment the effect of ridging of the crop on lodging and yield was investigated. It was seen that though ridging helped to prevent lodging to a slight extent there was no significant increase in yield between the ridged and non-ridged plots.

(4) *Lodging in relation to yield of crop.*

In this experiment, T. 1242 was grown under well manured condition and was artificially lodged at pre-flowering and post-flowering stages. Propped up plants served as control. It was found that the crop which lodged at pre-flowering and flowering stages suffered losses in yield amounting to 60 and 50 per cent respectively, while the loss due to lodging at the post-flowering stages was 18 per cent, compared to the propped up non-lodged crop.

(5) *Spacing experiment for second crop of rice*

The object of the experiment was to determine the optimum spacing for second crop of rice during December-April season. This practice, as reported earlier, has been recently introduced in the canal irrigated tracts of Orissa at the instance of this Institute. The following spacings were tried i.e., 9"×4", 12"×13½" and 15"×2½" with 4"×4" as control. The maximum yield was obtained with the closed spacing of 4"×4".

(6) *Trial of intercultural practices*

An experiment was carried out to determine the effect of three intercultural practices, viz., (1) working Japanese weeder, (2) working country plough and (3) hand-weeding, on the yield of transplanted low land crop (T. 1242). These intercultural operations were carried out once in a fortnight till a month before the flowering of the crop. There was no difference between the treatments, as far as the grain yield was concerned.

IV. **Intensive Cultivation Centre**

Propaganda, demonstration of improved cultural practices, such as growing green manure, application of fertilizers etc., and distribution of improved seeds were continued in the intensive cultivation centre. The following are the important features of the work done during this year:

- (1) 650 md. seed of high yielding rice strains, giving 10-15 per cent more yield than the farmers' varieties, was distributed.

- (2) Demonstrating the advantages of sowing rice mixed with *dhaincha*, the crop of the latter being buried as green manure for the rice crop at the time of *bushenning*.
- (3) Popularising the economic seed rate of about 60-80 lb. per acre instead of the local seed rate of 100-120 lb. per acre.
- (4) Recommending the practice of either dibble sowing, or transplanting rice crop instead of broadcast sowing.
- (5) Popularising the growing of *dhaincha* plants along the field *bunds* at the time of *bushenning* for seed purposes.
- (6) Educating the farmers regarding the need for maintaining the nucleus seed pure and actually demonstrating to them in the field as to how to keep the seeds pure by roguing off-types at the flowering and ripening periods of the crop.
- (7) Conducting varietal trials in the cultivators' field with the improved paddy strains evolved at Central Rice Research Institute.

TRAINING

Post-Graduate Course

Three Botany and three Agronomy 2nd year post-graduate students of the Indian Agricultural Research Institute associate-ship course specialising in rice joined the Institute for doing the thesis part of the course and worked on the following research problems:

Botany

1. Studies on the inheritance of anthocyanin pigmentation in interracial crosses in rice.
2. A comparative study of the anatomy and other plant characters of three diploid strains and corresponding autotetraploids of rice.
3. Morphological and anatomical studies in the genus *Oryza*.

Agronomy

4. Study of the yield response of rice crop to application of different doses of ammonium sulphate in combination with compost.
5. Study of the effect of varying doses of N. P. & K. in combination with organic manures on various agronomic plant characters and yield of rice.

6. Study of the performance of 36 varieties of rice for late *aman* and *boro* crops.

Refreshers Course

A 12 days Refreshers course, split into three sessions of 4 days' duration each in improved methods of rice cultivation, was held during the month of July, August and November 1954, for the benefit of the Extension staff of the Orissa Department of Agriculture and was attended by 14-22 Officers of the Department.

Village Level Workers Course

A training course in rice cultivation methods was held from 20th to 30th September, for the staff of the Orissa Community Project and was attended by 25 Village Level Workers.

PUBLICATIONS

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PROGRAMME OF WORK FOR 1955-56

AGRONOMY DIVISION

- (i) Study of yield performance of different duration varieties.
- (ii) Trial of varieties suitable for late *aman* planting and for double cropping.
- (iii) To determine the suitability of various crops for growing in rotation with rice.
- (iv) Study of the relative efficiency of various nitrogenous fertilizers.
- (v) Determination of the optimum dose, time and method of application of different nitrogenous fertilizers and their residual and cumulative effect on the soil fertility.
- (vi) Study of the response of rice to N. P and K nutrients and organic matter.
- (vii) Study of the efficiency of various herbicides for control of weeds in the rice fields and to determine the optimum dosage and time of their application.

STATISTICS

- (i) Estimation of yield by sampling for the ratio of grain to total produce.
- (ii) Sampling for pollen and spikelet sterility.
- (iii) Formulae for calculating linkage value from different F_2 ratios.
- (iv) The inheritance of height and flowering duration.
- (v) Estimation of leaf area constant.
- (vi) Continuation of border effect in varietal and manurial trials.

BOTANY DIVISION

- (i) Maintenance and study of genetic stocks including the F.A.O. world catalogue.
- (ii) Maintenance of nucleus seed of promising strains.
- (iii) Improving yield by,
 - (a) Introduction,
 - (b) Hybridization,
 - (1) Between *japonica* and *indica* rices.
 - (2) Within *indica* group for early maturity and high yield.
- (iv) Breeding for disease resistance.
- (v) Breeding for upland conditions.

(vi) Breeding for non-lodging habit.

(vii) Genetics: Linkage groups; Liguleless—auricle-less—juncture-less mutant; Non-lodging character, Spikelet—sterility; Dwarf mutant; Disease resistance; Pigmentation and awning in inter-racial crosses.

(viii) Cytogenetics: Studies in cytology of interspecific hybrids and use of embryo cultures to raise the hybrids whenever necessary.

CHEMISTRY DIVISION

(i) Study of the water-logged soil state—nitrogen transformation, phosphate changes on water-logging, availability and uptake by crop.

(ii) Investigations on phosphatic fertilization on rice crop, its direct and cumulative effect.

(iii) Study of sampling technique of wet rice soils, for analytical and advisory purposes and standardization of methods of analysis for wet unoxysidised soil.

(iv) Study of tissue tests and quick methods of determination of nutrient deficiencies and reserve in rice plant grown under different cultural and manurial conditions.

ENTOMOLOGY DIVISION

(i) Studies of reactions of World Genetic Stock to pests with a view to isolating resistant strains to insect damage (*Sarad* and *Dalua*).

(ii) Varietal susceptibility and agronomic practices in their relation to pests in general and borers and gall-fly in particular.

(iii) Estimation of loss due to pests particularly, *Schoenobius*, *Pachydiplosis* and *Leptocorisa* in the field.

(iv) Effect of Gall-fly and Stemborer attack on tillering and yield.

(v) Studies on gall formation in paddy.

(vi) Seedling treatment to control gall-fly, leaf-hoppers and stem borers,

(vii) Insecticidal trials to control pests in the field.

(viii) Japanese method of cultivation and the incidence of pests.

(ix) Efficacy of low volume spraying.

(x) Studies of alternate hosts of major pests of paddy.

(xi) Collection of indigenous parasites with a view to utilising them for biological control of pests of paddy.

(xii) Efficacy of Aluminium Bin for storage of paddy.

MYCOLOGY DIVISION

(i) Study and estimation of resistance to diseases in field of types under genetic stocks.

(ii) Helminthosporium disease:

- (a) Tests of resistance of selected varieties under artificial and natural infection.
- (b) Co-ordinated trial of selected resistant varieties in different States in India.
- (c) Artificial infection tests on early types in genetic stock for selection of resistant types.
- (d) Identification and estimation of air borne conidia over rice fields.
- (e) Breeding resistant varieties.
- (f) Study of the nature of disease resistance of rice varieties.

(iii) Blast disease:

- (a) Tests of resistance of selected varieties under natural infection in field experiments.
- (b) Co-ordinated trial of selected resistant varieties in different States in India.
- (c) Artificial infection tests on early types in genetic stock for selection of resistant types.
- (d) Breeding resistant varieties: Study of resistance in and F_3 s
- (e) Control of blast by spraying.

(iv) Seed treatment of rice with fungicides.

FARM DIVISION

(i) Multiplication of improved paddy strains.

(ii) Determining the merits of (1) dibbling, (2) broadcast sowing of sprouted seeds in puddle and (3) transplanting under optimum conditions.

(iii) Determining the effect of ridging on (1) dibbled and (2) transplanted crop.

(iv) Investigation on the efficacy of the seedlings raised under the different systems namely, (1) Japanese methods (2) dibbling seed behind plough furrows in the seed bed and (3) the customary practice of dry sowing.

(v) Study of factors connected with loss in yield due to lodging.

(vi) Maximisation of crop yield by heavy manuring and under improved methods of cultivation.

(vii) Enlargement of the extension work in the Intensive Cultivation Centre.

STAFF (1954-55)

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AGRONOMY DIVISION

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